Pediatr Neonatol 2009;50(1):8–12

ORIGINAL ARTICLE

Concomitant Rotavirus and *Salmonella* Infections in Children with Acute Diarrhea

Wen-Tzong Lan[1], Hung-Chang Lee[1,2]*, Chun-Yan Yeung[1], Chuen-Bin Jiang[1], Hsin-An Kao[1], Han-Yang Hung[1], Nan-Chang Chiu[1]

[1]*Department of Pediatrics, Mackay Memorial Hospital, Taipei, Taiwan*
[2]*Department of Pediatrics, Taipei Medical University, Taipei, Taiwan*

Received: Jul 5, 2007
Revised: Jul 7, 2008
Accepted: Dec 1, 2008

KEY WORDS:
acute gastroenteritis;
concomitant infection;
rotavirus;
Salmonella

Background and purpose: The incidence of concomitant rotavirus and *Salmonella* infection has been reported to be 1.3% to 7.4%. We designed this study to compare the clinical manifestations in children infected with rotavirus, *Salmonella*, or both.
Methods: The medical records of admitted children with acute rotavirus or *Salmonella* gastroenteritis in 2001 were reviewed. They were divided into group R (rotavirus), group S (*Salmonella*) and group C (concomitant infection with both). The differences of clinical manifestations and laboratory data among the three groups were analyzed via chi-squared, analysis of variance (ANOVA), Bonferroni and Kruskal-Wallis tests, and odds ratios with 95% confidence intervals (95% CI).
Results: Among the 895 cases reviewed, 550 were group R, 312 group S, and 33 (3.7%) group C. Group C had more vomiting compared with group S ($p=0.0017$) ($p<0.05$), more prolonged and high fever (≥39ºC) ($p<0.05$), more percentage of green coloration, with mucus and blood contained in the stool ($p<0.001$). The C-reactive protein (CRP) value was significantly higher in group C (9.70±11.05 mg/dL) than in group R (1.33±3.62 mg/dL) or S (5.22±6.11 mg/dL) ($p<0.05$). Hypokalemia was found most frequently in group C (C: 30.0%, S: 8.8%, R: 7.3%) ($p=0.0026$).
Conclusion: Concomitant rotavirus and *Salmonella* infections accounted for 3.7% of cases in this study. Patients in group C (30.0%) had a significantly higher incidence of hypokalemia than group R (7.3%) or S (8.8%). Group C consisted of 33 cases of the 895 reviewed cases (3.7%). In a child with rotavirus gastroenteritis, concomitant infection with *Salmonella* should be considered if the child has sustained a high fever (≥39ºC) for over 4 days and a green stool with mucus and blood.

1. Introduction

Rotavirus is the most common viral and *Salmonella* the most common bacterial cause in children with acute diarrhea.[1–3] Their similar findings were delineated in previous reports in Taiwan.[4–9] The clinical features of infection with only one agent are fairly distinctive. Rotavirus gastroenteritis tends to cause mild to moderate fever, vomiting, and a watery stool. Most fatalities occur in infants with poor access to medical care and are attributed to dehydration.[2] The epidemiology of rotavirus infection is heavily influenced by the local climate. Although rotavirus has been identified as the major pathogen associated

*Corresponding author. Department of Pediatrics, Mackay Memorial Hospital, 92 Section 2, Chung-Shan North Road, Taipei 104, Taiwan.
E-mail: ped2435@ms2.mmh.org.tw

with "winter" gastroenteritis, the seasonal peak may vary with different climates.[6] *Salmonella* infection occurs with its highest frequency in the warm months.[10] *Salmonella* infection is more likely to present with fever, crampy abdominal pain, and blood mixed with the stool.[11] The incidence of concomitant rotavirus and *Salmonella* infection has been reported to be 1.3% to 7.4%.[12,13] However, the clinical manifestations in children hospitalized with simultaneous rotavirus and *Salmonella* infections have not been well described. We designed this study to compare the clinical findings in children infected with rotavirus, *Salmonella*, or both.

2. Materials and Methods

The medical records of 1114 children admitted to Mackay Memorial Hospital with acute rotavirus or *Salmonella* gastroenteritis from January to December 2001 were reviewed. Patients complicated with intestinal perforation were excluded. We also excluded patients who had underlying diseases such as neuroblastoma, myopathy, histocytosis, acute pyelonephritis, etc., leaving 895 records for review. The stool samples had been studied for bacterial culture and rotavirus antigen simultaneously at admission. Stool and blood cultures were performed by using selective media plates, including a *Salmonella–Shigella* medium and a Hektoen enteric medium. *Salmonella* serogrouping was determined by using commercial antiserum (Denka Seken Co.). An enzyme immunoassay (Premier Rotaclone) was used to detect the rotavirus antigen in fecal specimens. They were divided into group R (rotavirus), group S (*Salmonella*) and group C (concomitant infection with both pathogens). Clinical manifestations and laboratory data were recorded to compare the differences among the three groups. A chi-square test was used to detect the difference of categorical variables; whereas analysis of variance (ANOVA) was used to detect the difference of continuous variables. When the ANOVA test gave a significant difference, then Bonferroni test was used as a posterior-hoc test. The Kruskal-Wallis test was used for detecting the mean difference on C-reactive protein (CRP) in pathogens since the normal distribution was not assumed. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated. A p value of less than 0.05 was defined as significant.

3. Results

Among the 895 cases of acute diarrhea reviewed, 550 (61.4%) were caused by rotavirus alone (group R), 312 (34.9%) by *Salmonella* alone (group S), and 33 (3.7%) by both pathogens (group C). There were 499 males and 396 females in the study sample, with the ratio of male to female in each group as follows: group C, 18:15; group R, 309:241; and group S, 172:140. The gender ratios did not differ significantly among the three groups ($p=0.946$) (Table 1). The mean ($\pm$SD) age in months at admission for group C was 21.2$\pm$23.7; for group R, 23.7$\pm$18.2 and for group S, 19.5$\pm$21.6. The interval between date of onset and date of admission in group C was 2.6$\pm$1.9 days in group R, 2.4$\pm$2.0 days and in group S, 3.2$\pm$2.5 days. There was no significant difference in the interval between group C and the other two groups. The length of hospital stay in groups C (7.1$\pm$3.7 days) and S (6.6$\pm$3.5 days) were significantly greater than that of group R (4.6$\pm$1.9 days; $p<0.05$), but there was no difference between groups C and S (Table 1). The peak of seasonal occurrence in group C (September, 27.3%) was between those of group R (May, 12.4%, and October, 12.1%) and group S (June, 15.4%, July, 13.5%, and August, 16.4%) (Table 1).

The percentages of patients with high fever (i.e. a temperature $\geq$39ºC) in groups C (85.2%, OR [95% CI]3.3[1.1–9.7], $p=0.0222$) and S (83.1%, OR [95% CI]2.8[1.9–4.2], $p<0.001$) were significantly greater than in group R (63.5%), with no significant difference between groups C and S ($p=0.7846$) (Table 1). The duration of fever in group C was significantly longer than that in group R (C: 4.8$\pm$2.7 days, R: 3.0$\pm$1.8 days; $p<0.05$). Significantly more children in group C had vomiting compared with group S (C: 66.7%, OR [95%CI]0.6[0.3–1.2], S: 38.5%, OR [95% CI]0.2[0.1–0.2]; $p=0.0017$). The mean daily frequency of diarrhea in group S was significantly more than that in group R (S: 7.6$\pm$3.7, R: 6.5$\pm$3.4; $p<0.05$), but there was no significant difference between group C and the other two groups. However, significantly more children in group C had green stools compared group R (C: 57.6%, OR [95% CI]4.3[2.1–8.8], R: 24.1%; $p<0.001$). There were significant differences in the presence of mucus (R: 18.9%, S: 54.2%, OR [95% CI]5.1[3.7–6.9], C: 33.3%, OR [95% CI]2.1[1.0–4.6]; $p<0.001$) and blood (R: 7.1%, S: 59.6%, OR [95% CI]16.1[10.8–24.0], C: 24.2%, OR [95% CI]3.5[1.5–8.3]; $p<0.001$) in the stool. The groups did not differ significantly in terms of abdominal bloating (R: 70.7%, S: 77.2%, OR [95% CI]1.4[1.0–1.9], C: 69.7%, OR [95% CI]1.0[0.4–2.0]; $p=0.107$), pain (R: 17.3%, S: 18.3%, OR [95% CI]1.1[0.7–1.5], C: 9.1%, OR [95% CI]0.5[0.1–1.6]; $p=0.415$), seizures (R: 3.8%, S: 2.2%, OR [95% CI]0.6[0.2–1.4], C: 3%, OR [95% CI]0.8[0.1–6.0]; $p=0.454$), or dehydration (R: 14.6%, S: 14.1%, OR [95% CI]1.0[0.6–1.4], C: 21.2%, OR [95% CI]1.6[0.7–3.8]; $p=0.544$). However, flu-like symptoms were significantly more common in group R compared with group S (R: 48.9%, S: 36.5%, OR [95% CI]0.6[0.5–0.8]; $p=0.0004$) (Table 1).

Table 1 Symptoms of rotavirus, *Salmonella*, and concomitant infections

Clinic manifestation	Rotavirus infection	*Salmonella* infection	Concomitant infection	*p* value
Sex (male/female)	309/241	172/140	18/15	0.946
OR (95% CI)	1.0	1.0 (0.7–1.3)	0.9 (0.5–1.9)	
Age (mo)	23.7±18.2	19.5±21.6	21.2±23.7†	0.010
(*n*, range)	(550, 0–135)	(312, 1–180)	(33, 1–185)	
Days from onset to	2.4±2.0	3.2±2.5	2.6±1.9†	0.001
admission (*n*, range)	(545, 0–13)	(311, 0–18)	(33, 0–9)	
Length of stay (days)	4.6±1.9*	6.6±3.5	7.1±3.7	0.001
(*n*, range)	(550, 1–15)	(312, 1–20)	(33, 3–19)	
Days from onset to	7.0±2.8*	9.8±4.5	9.7±4.5	0.001
discharge (*n*, range)	(546, 2–28)	(312, 2–35)	(33, 4–24)	
Fever	499/550 (90.7%)	292/311 (93.9%)	32/33 (97.0%)	0.1459
OR (95% CI)	1.0	1.6 (0.9–2.7)	3.3 (0.4–24.4)	
BT ≥39ºC	259/408 (63.5%)*	187/225 (83.1%)	23/27 (85.2%)	<0.001
OR (95% CI)	1.0	2.8 (1.9–4.2)	3.3 (1.1–9.7)	
Duration (days)	3.0±1.8*	5.3±2.7	4.8±2.7	<0.001
(*n*, range)	(458, 1–17)	(260, 1–18)	(30, 2–12)	
Flu	269/550 (48.9%)	114/312 (36.5%)	13/33 (39.4%)†	0.002
OR (95% CI)	1.0	0.6 (0.5–0.8)	0.7 (0.3–1.4)	
Vomiting	430/550 (78.2%)	120/312 (38.5%)*	22/33 (66.7%)	<0.001
OR (95% CI)	1.0	0.2 (0.1–0.2)	0.6 (0.3–1.2)	
Bloating	389/550 (70.7%)	241/312 (77.2%)	23/33 (69.7%)	0.107
OR (95% CI)	1.0	1.4 (1.0–1.9)	1.0 (0.4–2.0)	
Pain	95/550 (17.3%)	57/312 (18.3%)	3/33 (9.1%)	0.415
OR (95% CI)	1.0	1.1 (0.7–1.5)	0.5 (0.1–1.6)	
Dehydration	80/550 (14.6%)	44/312 (14.1%)	7/33 (21.2%)	0.544
OR (95% CI)	1.0	1.0 (0.6–1.4)	1.6 (0.7–3.8)	
Seizure	21/550 (3.8%)	7/312 (2.2%)	1/33 (3.0%)	0.454
OR (95% CI)	1.0	0.6 (0.2–1.4)	0.8 (0.1–6.0)	
Stool times (days)	6.5±3.4	7.6±3.7	7.0±2.4†	<0.001
(*n*, range)	(430, 1–25)	(285, 1–30)	(25, 3–10)	
Stool color				
Yellow	417/549 (75.9%)	131/312 (42.0%)	14/33 (42.4%)	
OR (95% CI)	1.0	0.2 (0.2–0.3)	0.2 (0.1–0.5)	
Green	132/549 (24.1%)*	181/312 (58.0%)	19/33 (57.6%)	<0.001
OR (95% CI)	1.0	4.4 (3.2–5.9)	4.3 (2.1–8.8)	
Stool mucus‡	104/550 (18.9%)	169/312 (54.2%)	11/33 (33.3%)	<0.001
OR (95% CI)	1.0	5.1 (3.7–6.9)	2.1 (1.0–4.6)	
Stool blood‡	39/550 (7.1%)	186/312 (59.6%)	8/33 (24.2%)	<0.001
OR (95% CI)	1.0	16.1 (10.8–24.0)	3.5 (1.5–8.3)	

*Significantly different from the other two groups ($p<0.05$). †Not significantly different from the other two groups ($p>0.05$). ‡Significant difference among all three groups ($p<0.05$). BT = Body temperature; OR = odds ratios; CI = confidence intervals.

The percentage of *Salmonella* serogroups in the stool cultures of patients in group C *vs.* group S were as follows: B, 56.0% *vs.* 48.5%; C, 16.9% *vs.* 24.3%; D, 24.1% *vs.* 21.2%; E, 0.7% *vs.* 3.0%; and untyped species, 2.3% *vs.* 3.0%. In group C cultures, 59.4% of isolates were resistant to ampicillin, compared with 40.3% in group S ($p=0.0379$). One isolate in group C and two in group S were resistant to ceftriaxone. The percentages of children with bacteremia were 3.0% in group C and 11.2% in group S.

There was no significant intergroup difference in white blood cell (WBC) count (R: 10,797±4679/mm^3, S: 10,734±4375/mm^3, C: 11,330±3630/mm^3; $p=0.774$) or in the incidence of hyponatremia (R: 12.5%, S: 11.2%, OR [95% CI]0.9[0.5–1.7], C: 5.0%, OR [95% CI]0.4[0.1–2.3]; $p=0.5860$) (Table 2). However,

Table 2 Laboratory data in rotavirus, *Salmonella*, and concomitant infections

	Rotavirus infection	*Salmonella* infection	Concomitant infection	*p* value
WBC (/mm^3) (*n*, range)	10,797±4679 (549, 2580–35,500)	10,734±4375 (310, 1360–35,610)	11,330±3630 (33, 6200–20,360)	0.774
ESR (mm/hr) (*n*, range)	18.0±13.0 (81, 2–75)	35.0±17.5* (38, 10–87)	16.8±9.3 (5, 7–29)	<0.001
CRP (mg/dL)† (*n*, range)	1.33±3.62 (293, 0–14.8)	5.22±6.11 (214, 0–29.9)	9.70±11.05 (23, 0–31.1)	<0.001
CRP >0.8 (mg/dL) OR (95% CI)	94/298 (31.5%)* 1.0	173/225 (76.9%) 7.2 (4.9–10.7)	14/23 (60.9%) 3.4 (1.4–8.1)	<0.001
CRP >10 (mg/dL)† OR (95% CI)	6/293 (2.1%) 1.0	35/214 (16.4%) 9.4 (3.9–22.7)	9/23 (39.1%) 30.8 (9.6–98.5)	<0.001
Na <135 (mEq/L) OR (95% CI)	36/288 (12.5%) 1.0	14/125 (11.2%) 0.9 (0.5–1.7)	1/20 (5.0%) 0.4 (0.1–2.3)	0.5860
K <3.5 (mEq/L) OR (95% CI)	21/286 (7.3%) 1.0	11/125 (8.8%) 1.2 (0.6–2.6)	6/20 (30.0%)* 3.8 (1.4–10.4)	0.0026

*Significantly different from the other two groups ($p<0.05$). †Significant difference among all three groups ($p<0.05$). WBC = white blood cell; ESR = erythrocyte sedimentation rate; CRP = C-reactive protein; OR = odds ratios; CI = confidence intervals; mEq/L = milliequivalents per litre.

patients in group C (30.0%, OR [95% CI]3.8[1.4–10.4]) had a significantly higher incidence of hypokalemia than group R (7.3%, $p=0.0006$) or S (8.8%, OR [95% CI]1.2[0.6–2.6], $p=0.0062$). The CRP value in group C (9.70±11.05 mg/dL) was significantly higher than in groups R (1.33±3.62 mg/dL, $p<0.05$) and S (5.22±6.11 mg/dL, $p<0.05$). Using a cutoff for CRP of >0.8 mg/dL, the percentage of patients with an elevated value was significantly greater in groups S (76.9%, OR [95% CI]7.2[4.9–10.7], $p=0.0041$) and C (60.9%, OR [95% CI]3.4[1.4–8.1], $p<0.0001$) than in group R (31.5%), but there was no difference between group C and S ($p=0.0893$). Using a cutoff of >10 mg/dL, significantly more children in group C (39.1%, OR [95% CI]30.8[9.6–98.5]) had an elevated value compared with groups R (2.1%, $p<0.0001$) and S (16.4%, OR [95% CI]9.4[3.9–22.7], $p=0.0076$). The mean ESR in group S (35.0±17.5 mm/hr) was significantly greater than in groups R (18.0±13.0 mm/hr, $p<0.05$) and C (16.8±9.3 mm/hr, $p<0.05$) (Table 2). However, only 5 of the 33 patients in group C had an ESR recorded in the record.

4. Discussion

Rotavirus and *Salmonella* were found to be the most common pathogens in viral and bacterial diarrhea in children. The same results were reported in the previous data in Taiwan.[14,15] The differentiation between them is important because they may have different complications and need different treatment. However, concomitant rotavirus and *Salmonella* infection did occur (3.7% in this study). A previous study identified vomiting as a key clinical feature that was significantly more common among patients with rotavirus than among those with diarrhea due to other causes.[16] In comparison of rotavirus or non-specified gastroenteritis with *Salmonella* enteritis, the latter was significantly more likely to lead to blood and mucus in the stool, fever during admission, more stools per day, a longer hospital stay, and to occur in younger patients.[17] In this study, we found that patients with concomitant rotavirus and *Salmonella* infections tended to be more seriously ill than those with rotavirus alone. They had not only vomiting, but also sustained fever (≥39°C) for more than 4 days, and a green stool with mucus and blood. It has been reported there was a close relationship between rotavirus and benign afebrile seizure.[18–21] In this study, seizures were rare (<4%), with no different incidence between the three groups.

The white blood cell (WBC) count is not helpful in diagnosing bacterial enteritis in children,[22] and our findings were consistent with this statement. Another group has suggested that a CRP >1.2 mg/dL may be useful for predicting bacterial gastroenteritis in children.[23] Conversely, a high negative predictive value for a low CRP (<2.0 mg/dL) might allow clinicians to reliably exclude *Salmonella* as a cause of gastroenteritis.[22] Our study revealed that when using a low cutoff for CRP (>0.8 mg/dL) the percentage of patients with concomitant infection who had a positive result was between that for *Salmonella* or rotavirus infection alone. The percentage of patients with concomitant infection who had a CRP >10 mg/dL was also significantly greater than in the other two groups. Overall, patients with concomitant

infection had higher CRP values than those with rotavirus infection alone. Hypokalemia was also most frequent in concomitant infection, but a reported predisposition to hyponatremia in *Salmonella* enteritis was not substantiated in our study.[13]

Chang reported that bacteremia occurred in 38% of *Salmonella*-infected patients less than 3 months of age.[24] *Salmonella* bacteremia also has been documented in afebrile, well-appearing children, especially neonates.[10] On the other hand, most newborns infected with rotavirus are afebrile.[2] In our study, only one third of children under 3 months of age had fever.

The most common pathogen in the *Salmonella* enteritis cases was serogroup B, which was also the most common pathogen in both concomitant infection and isolated *Salmonella* infection in this study.[25–27] We also found that the serogroup B *Salmonella* in concomitant infection had higher incidence of resistance to ampicillin. Although Bukholm's study indicated a specific interaction between rotavirus-infected cells and facultatively intracellular enteropathogenic bacteria, the mechanism of ampicillin resistance in the *Salmonella* strain involved in concomitant rotavirus and *Salmonella* infection is not clear.[28]

Our study indicated that the lengths of hospitalization for children with concomitant infection and those with *salmonella* alone were similar, and for both groups, length of hospitalization was significantly longer than that for the rotavirus group. This is consistent with the findings of a study in Singapore.[3]

In summary, concomitant rotavirus and *Salmonella* infection accounted for 3.7% of cases in this study. There may be an elevated CRP and hypokalemia. In a child with rotavirus gastroenteritis, concomitant infection with *Salmonella* should be considered if the child has a sustained high fever (≥39°C) for over 4 days and a green stool with mucus and blood.

References

1. Blacklow NR, Greenberg HB. Viral gastroenteritis. *N Engl J Med* 2001;325:252–64.
2. Bass DM. Rotavirus and other agents of viral gastroenteritis. In: Behrman RE, Kliegman RM, Jenson HB, eds. *Nelson Textbook of Pediatrics*, 16th ed. Philadelphia: WB Saunders, 2000:996–8.
3. Quak SH. Gastrointestinal infections in Singapore children. *Ann Acad Med Singap* 1991;20:265–8.
4. Chyou SC, Leu YJ, Huang FY, et al. An etiological study of infectious diarrhea in infants and children in Taipei area. *Acta Paediatr Sin* 1988;29:213–20.
5. Chen HJ, Chen BS, Wang SF, et al. Rotavirus gastroenteritis in children: a clinical study of 125 patients in Hsin-Tien area. *Acta Paediatr Sin* 1991;32:73–8.
6. Chiu TF, Lee CN, Lee PI, et al. Rotavirus gastroenteritis in children: 5-year experience in a medical center. *J Microbiol Immunol Infect* 2000;33:181–6.
7. Tsai CH, Chiu HH, Abe T. Epidemiologic features of rotavirus infection in Taiwan: a review. *Pediat Int* 2000;42: 411–4.
8. Yang MT, Chi CS. *Salmonella* infections in infants and children. *Chin Med J (Taipei)* 1994;54:38–43.
9. Chang JS, Tsai CH, Chang YC, Lin HC. Non-typhoidal *Salmonella* bacteremia and gastroenteritis in infancy: a five-year retrospective study. *J Infect Dis Assoc ROC* 1990;3:35–8.
10. Cleary TG. *Salmonella*. In: Behrman RE, Kliegman RM, Jenson HB, eds. *Nelson Textbook of Pediatrics*, 16th ed. Philadelphia: WB Saunders, 2000:842–8.
11. Guandalini S. Acute diarrhea. In: Walker WA, Durie PR, Hamilton JR, Walker-Smith JA, Watkins JB eds. *Pediatric Gastrointestinal Disease*, 3rd ed. Ontario: BC Decker, 2000:28–36.
12. Ling JM, Cheng AF. Infectious diarrhoea in Hong Kong. *J Trop Med Hyg* 1993;96:107–12.
13. Khuffash FA, Sethi SK, Shaltout AA. Acute gastroenteritis: clinical features according to etiology agents. *Clin Pediatr* 1988;27:365–8.
14. Chen SM, Ni YH, Chang MH, et al. Microbial etiology of acute gastroenteritis in hospitalized children in Taiwan. *J Formos Med Assoc* 2006;105:964–70.
15. Peng CF. Incidence and antimicrobial resistance of *Salmonella* serotypes in southern Taiwan from 1978 through 1987. *Kaohsiung J Med Sci* 1992;8:247–54.
16. Man NV, Trang NV, Lien HP. The epidemiology and disease burden of rotavirus in Vietnam. *J Infect Dis* 2001;183: 1707–12.
17. Nelson EA, Mork TC, Yu LM. Retrospective comparison of management of gastroenteritis in hospitalized children. *Ann Trop Paediatr* 2002;22:165–7.
18. Wong V. Acute gastroenteritis-related encephalopathy. *J Child Neurol* 2001;16:906–10.
19. Contino MF, Lebby T, Arcinue EL. Rotaviral gastroenteritinal infection causing afebrile seizures in infancy and childhood. *Am J Em Med* 1994;12:94–5.
20. Lin SH, Hsu HY, Wang SM, et al. Rotavirus gastroenteritis associated with afebrile seizure in childhood. *Acta Paediatr Sin* 1996;37:204–7.
21. Schumacher RF, Forster J. The CNS symptoms of rotavirus infections under the age of two. *Klinische Padiatrie* 1999;211:61–4.
22. Meloni GF, Tomasi PA, Spanu P, et al. C-reactive protein levels for diagnosis of *Salmonella* gastroenteritis. *Pediatr Infect Dis J* 1999;18:471–3.
23. Borgnolo F, Barbone F, Guidobaldi G, et al. C-reactive protein in viral and bacterial gastroenteritis in childhood. *Acta Paediatr* 1996;85:670–4.
24. Chi H, Sun W, Chan WT, et al. Pediatric *Salmonella* enterocolitis in a teaching hospital in Taitung: a four-year analysis. *Acta Paediatr Taiwan* 2001;42:297–300.
25. Sheu CL, Wu TC, Hwang BT. Retrospective study of *Salmonella* gastroenteritis in infants. *Chin Med J (Taipei)* 1990;46:232–6.
26. Huang FY, Huang SH, Lin CH, et al. Bacteremia in infants with *Salmonella* enterocolitis. *Acta Paediatr Sin* 1991;32: 358–64.
27. Huang IF, Wagener MM, Chiou CC, et al. Nontyphoid salmonellosis in Taiwan children: clinical manifestations, outcome and antibiotic resistance. *J Pediatr Gastroenterol Nutr* 2004;38:518–23.
28. Bukholm G. Human rotavirus infection enhances invasiveness of enterobacteria in MA-104 cells. *APMIS* 1988;96:1118–24.